from navigating the former. As to the reason why such a memento should be left of the visit, of course no definite answer can be given, but it is a fact well known that memorials were often made or erected, engraved or placed at localities where events had taken place, and the address of the chieftain to the men may have been of some noteworthy matter, perhaps even to commemorate the fact of having landed at that spot.

In conclusion, I would say, that the circumstances are worthy of consideration, if not absolutely convincing.

On the Clinton and other Shales, &c., composing the Fifth Group of Rogers in the First Survey of Pennsylvania. By Prof. E. W. Claypole.

(Read before the American Philosophical Society, March 21, 1884.)

This group has been the field for considerable discussion in regard to the proper place of its different beds when compared with those supposed to be of similar or nearly similar age in New York. It has not been easy to prove where one formation began and another ended. By throwing all those shales into a single group Prof. Rogers avoided discussion on this point and No. 5 became a local or Pennsylvanian term. The group has the merit of being a very natural one regarded from a physical standpoint. Based on the massive Medina sandstone, and capped by the conspicuous Lewistown limestone, there was no question of its physical limits in the State, and all further differentiation was postponed.

But with the advance of geology, the necessity arises for closer comparison and correlation. It is not enough to suppose that the fifth group of Rogers corresponds with the New York beds between the top of the Medina sandstone, and the Lewistown or Lower Helderberg limestone. More exact division and definition are desirable, and my recent work in Perry county has put into my hands the means of examining this question in a new method—by the means of the fossils. Palæontology has hitherto done little towards its solution, and by palæontology alone in many cases can the true solution be reached.

In the present paper I propose to examine these rocks constituting the fifth group of Rogers, and to set forth the evidence thus far attainable, both stratigraphical and palæontological, for the places assigned to them among the palæozoic rocks.

The Clinton Group.

Beginning at the top of the Medina sandstone regarding the age of which there has been no question I will consider first the beds lying upon it in Perry county. These are shown in the following section :

Section of the Rocks in Perry County correlated with the Clinton Group of New York.

Fossil hæmatite and limestone		2 feet.
Sandrock		5 "
Hæmatite		1 "
Sandrock		5 "
Upper green shale	Shale, green	160 "
	Iron sandstone	2 "
	Fossil ore	1 "
	Shale, green	200 "
Iron sandstone		10 "
Hard fossil block ore		3 "
Lower green shale		600 "
		989

Medina sandstone.

The thickness here assigned to the different beds is not a constant quantity, and the diagram does not represent any actual section. It is, with this exception, accurate wherever the whole series crops out in the county. The measurements have been taken or estimated where it was possible to obtain them, and the details may be found in the forthcoming report on Perry county.

Comparison with the Clinton Rocks of New York.

Ft.	*New York.*	Ft.	*Perry Co., Pa.*
18.4	Limestone.	2	Limestone and hæmatite.
		5	Sandrock
		1	Hæmatite.
	Iron Ore.	5	Sandrock.
24.0	Upper green shale.	363	Upper green shale and fossil ore.
15.2	Iron ore and limestone.	13	Iron sandstone and fossil ore.
23.0	Lower green shale.	600	Lower green shale.
	Thickness, 80 ft. 6 inches.		Thickness, 989 feet.

Points of Difference.

Diversity of opinion may prevail in regard to the identity of the beds of iron ore on the above diagram, but this is of little moment. They are usually discontinuous and probably their horizons vary. This is the case even within the limits of Perry county and cannot therefore excite surprise at the distance of several hundred miles.

No sandstone is shown on the New York section and little limestone in Pennsylvania, but the sandstones in the latter are thin, only 10 and 20 feet thick respectively, and the same is true of the limestones of New York.

Beds so thin are not likely to be continuous over so great a distance. Such discrepancies are due to difference of conditions during deposition. They are no argument against correspondence.

Points of Resemblance.

It is impossible to avoid noticing the close correspondence, in general, between the two sections looked at as wholes. The lower parts of the two sections are absolutely identical except in thickness. And in Perry county the lower portion includes 965 feet out of the 989 which represent the total mass. In New York it includes 62 feet 2 inches out of the total 80 feet 6 inches. That is, practically, the column presents a close resemblance in the two sections through three-fourths of its length in New York and through forty-nine fiftieths of its length in Perry Co., Pennsylvania. Closer correspondence could not be looked for.

This reduction of its mass also brings the group in Pennsylvania into rather closer resemblance in thickness, to that which it possesses in New York. It is still vastly thicker, but this is the usual condition. If the whole of the shales of the fifth group be included the disproportion is enormous.

The resemblance can be traced even into more minute detail. Prof. Hall describes the *Lower green shale* as consisting of thin smooth laminæ containing lenticular masses of limestone. If sandstone be substituted for limestone, these words exactly describe the Lower green shale of Perry Co. Of the *Lower limestone* he says: "This mass is composed almost entirely of thin beds of impure limestone which alternate with thin layers of green shale." Again the change of the word will adapt the description to the iron sandstone and ore of Perry Co. Of the *Upper green shale* we read (p. 64): "This is readily distinguished from the Lower green shale by its being everywhere fossiliferous;" a statement also true of the two shales in Pennsylvania. The Lower has yielded me almost nothing, while from the Upper I have obtained a fair collection.

Stratigraphically, therefore, it is almost impossible to expect a closer agreement between two correlated beds than that which we actually find here. And unless contrary evidence be found elsewhere, it is not only a reasonable, but an inevitable inference that these beds must be considered equivalents.

Palæontological Evidence.

It is not possible at present to give in full the evidence furnished by palæontology in favor of the classification above adopted. The suspension or termination of the work of the survey in this department will delay for a considerable time the working out of the collection I have made and the making of a larger one. So far, however, as I have been able in the intervals of field work to study this material, it is decisively in favor of the views here set forth. A few details are appended, the parts of the group being taken in order.

Lower Shale.

Omitting the lower shale, in consequence of the scarcity of its fossils so far obtained, and the fact that there is no question of its affinity, I pass on to the next member of the series ascending.

Iron Sandstone and Block Ore.

The Iron sandstone is in some places very fossiliferous, and, aside from the fossils which relate to my present purpose, has yielded me some which promise to be of considerable interest to palæontology. Two species, however, bear on the present subject.

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.

Both are distinctly Clinton species described from that group in New York.

Upper Green Shale.

The three species already recognized from this bed are

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.
Claymene Niagarensis, Hall.

All are Clinton species in New York, the last extending its range into the Niagara group also.

Ore Sandrock.

This rock is in many places abundantly fossiliferous. Again we find

Beyrichia lata, Vanuxem.
Calymene Clintoni, Vanuxem.

Sandvein Ore Bed.

The same evidence comes from this horizon. I have recognized

Beyrichia lata, Van.
Calymene Clintoni, Van.
Ormoceras vertebratum, Hall.

Thus we find the results of a study of the fossils completely in harmony, so far, with those deduced from the stratigraphy. Clinton fossils range up to and into the Sandvein ore bed.

On the other hand in all these beds I have not yet found a single specimen belonging to any other horizon. Negative evidence is therefore confirmatory. We have consequently palæontological evidence, at present scanty, it is true, but unmistakable, of the persistence of the typical Clinton fauna of New York up to and through the Sandvein ore bed.

Limit of the Clinton Fauna.

At this horizon the Clinton fauna, pure and alone, altogether ceases. Above the Sandvein ore bed (or limestone in some places) comes a mass of green shale and thin hard limestone bands about 150 feet thick, in which fossils are scarce, but from which I have obtained a few species. Among these the only ones yet recognized with certainty are :

Lingula oblonga, Hall.
Beyrichia notata, Hall.

The former of these is a Clinton species in New York, and the latter was described from the Lower Helderberg rocks. We have here, therefore, a mingling of the faunas of the two groups indicating passage beds from one to the other.* This commingling of species is limited, so far as I have yet observed, to the belt of green shales and limestones above mentioned. Immediately over it lies the great (Bloomsburg) *Red shale*, which is almost barren, but which will be discussed below. Here it will suffice to observe that no Clinton forms have been found in it.

Palæontology, therefore, fully bears out the division above adopted for the lower part of this great mass of shales and sandstones, which have been hitherto thrown together into that Limbo of shale, No. 5 of Rogers. The arrangement deduced from the above train of reasoning is as given below :

Table of the Clinton group as proposed for Perry county.

	Onondaga group.	Red shale.
150	Passage beds.	Green shale and limestone.
989	Clinton group.....	Sandvein ore bed.
		Ore sandrock and hæmatite.
		Upper green shale and fossil ore.
		Iron sandstone.
		Hard fossil block ore.
		Lower green shale.
1139		

These beds are thus correlated, with those in the Report of the First Survey of Prof. Rogers (Vol. I, p. 132), of which they are here considered equivalent.

Onondaga.	Red shale.	Surgent red shale.
Passage beds.	Green shale and limestone.....	Surgent upper shale.
Clinton.....	Ore sandrock and ore.	Ore sandstone.
	Upper green shale and ore.....	Lower shale, Upper slate.
	Iron sandstone and ore.....	Iron sandstone.
	Lower green shale	Lower slate.

* Later examinations render probable the presence of several other Clinton forms in these green shales and limestones, which will give a more decidedly Clinton aspect to the fauna without invalidating the conclusions here reached.

The Onondaga Salt Group, or Gypseous Group of New York, in Perry County, Pa.

Having thus, in appearance, satisfactorily placed the lower portion of Rogers' fifth group on the horizon of the Clinton of New York, I proceed to consider its upper portion.

This, in the district under consideration, consists of a vast mass of shales with almost no variation, except that caused by a few thin layers of sandstone. These shales are red at base, but graduate upward with gray beds, the red color disappearing as we ascend through the series. The lower or red portion is about 700 feet thick, and the upper or gray portion about 150 or 200 feet. These are separated by about 700 feet of what have been called the variegated shales, consisting of alternate beds of red, green and ashen-gray color with a few interbedded sandstones.

It would be of course natural to correlate this shale with the limestone immediately overlying the Clinton in New York, but for reasons, which will appear presently, I have preferred to make it the equivalent of the Onondaga group of New York, which immediately overlies the Niagara, and thus to leave the latter unrepresented in Perry county.

Stratigraphical and Lithological Evidence.

The Onondaga group of New York consists, like that just described, of a mass of variegated shales, and, as some of its names imply, it there yields salt and gypsum. Its total thickness, given by Vanuxem in the Report of the Third District, is about 700 feet, and it is divided as shown below. The section in Perry county is given in another column for comparison.

New York.	*Perry County, Pa.*
Magnesian rock = Limestone with Stylolites.	
Gypseous bed (upper). Porous (vermicular) limerock. Gypseous bed (lower).	Gray, calcareous marl.
Variegated shale (red and green).	Variegated shale (red and green).
Red shale.	Red shale.
Thickness 700 feet.	Thickness 1600 feet.

Very close correspondence exists between the beds at the two places. At both they consist, at base, of a thick mass of red shale. At both, overlying the red shale is another mass of varying color. At both, these two beds form the bulk of the group. So closely do the two sections resemble one another, that the description given of these lower beds in New York may be copied and applied literally to those in Perry county.

Mr. Vanuxem says (Report on Third District of New York, p. 96) of the red shale:

"The great mass is of a blood-red color, fine-grained, earthy in fracture, breaking or crumbling into irregular fragments."

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And of the variegated shale he says (p. 97):

"It consists of shales and calcareous slate of a light green and drab color, intermixing and alternating with the red shale at its lower part.

"Thus we have at the top of the series, green, then red under it, green, red, bluish, green and yellow, this latter by exposure to the air; then green and red layers with a little white and greenish sandstone, being several repetitions of the first two, and finally red shale as the lowest visible mass."

No better description can here be given of these two shales as they occur in Perry county.

The thickness of the separate beds is not given in Vanuxem's Report, but the total mass varies from 700 to 1000 feet. In Perry county the two lower masses—the red and variegated shales—measure 1400 feet, making the whole group, as usual, much thicker in Pennsylvania than in New York.

Again (p. 97.), "In several localities the red shale shows numerous green spots, varying from one inch or less to several inches in diameter.

"The red shale presents a thickness of from one to nearly 500 feet, yet nowhere has a fossil been discovered in it, or a pebble or anything extraneous, excepting a few thin layers of sandstone."

Similar green spots occur in the red shale in Perry county (near Wagoner's mill, for instance). The great scarcity of fossils is also remarkable, though these are not totally absent in Pennsylvania as will be mentioned farther on.

Advancing one step more let us compare the third division in Perry county with the similarly situated beds in New York. Here again we find the description of Vanuxem applicable to a great extent. He says (p. 99):

"The great mass of the deposit consists of rather soft, yellowish or drab and brownish colored shale and slate, both argillaceous and calcareous." It contains "argillaceous and calcareous slates, and more compact masses, which are hard." So in Perry county, though seldom exposed, this is the nature of the mass.

But one very important difference in these gray marls at the two places must be mentioned. No trace exists in this part of Pennsylvania of those concretions of gypsum which characterize the upper part of the Onondaga in New York, and which, together with its brine springs, render it the most valuable stratum in the State. These gray shales contain no valuable mineral, except the lime which enters largely into their composition. Such deposits as the gypsum and salt in New York rarely extend over very great tracts of country. Their absence in Perry county is not an objection sufficient to invalidate the argument. Indeed, the gypsum is not present over all the Onondagan outcrop in New York. Professor Hall says (Geol. of 4th District, p. 126), "There is a considerable space in the western part of Monroe county where no beds of gypsum are known."

Gypsum and salt, like iron ore, occur usually in scattered and discontinuous beds.

No closer correspondence can reasonably be looked for than that which I have here established between the Onondaga rocks in New York and those in Perry county, which I have placed in correlation with them. Only the uppermost stratum, called the Magnesian limerock, is unrepresented in the Pennsylvanian section. This is of inconsiderable thickness, measuring only twenty-four feet.

Palæontological Evidences.

The great barreness of these shales, which has been already alluded to, prevents the production of very strong evidence derived from their fossils. Only a single species bearing on the subject has rewarded a considerable amount of search. This is *Leperditia alta*, Conrad, which has been found in the Red shale in a few places abundantly, near Buffalo Mill, for example, in Saville township. It is also found in the second division—the Variegated shale—in Centre township, and becomes exceedingly abundant in its upper part, whole slabs being completely covered with its casts. These gray shales afford few opportunities of examination, but this species runs up into and through the massive limestones, forming in this county the lowest division of the Lower Helderberg rocks or Water Lime of New York. Above this horizon I have not found it.

In regard to this species Vanuxem says (l.c. p. 99):

"At one place only I succeeded in finding fossils in the second deposit (the Varigated shales), 'consisting of Cytherinæ' (Leperditiæ) about half the size of those in the group above."

In this respect, therefore, the correspondence is exact.

No fossils having been reported from the Red shale in New York, the presence of *Leperditia alta* in those of Perry county is not without interest, though it supplies no additional means of identification.

It has been mentioned that *Beyrichia notata* occurs in the passage bed below the Red shale. It may, therefore, be looked for in the Onondaga group, but I have not been able to find it. Its range, at present, is from the passage shales to the basal beds of the Lower Helderberg in Perry county, but it is yet known only in its extreme limits.

Summing up the evidence now presented, it is impossible to dispute the inference that the rocks above described are the real equivalent in Perry county of the Onondaga series in New York. By adopting this view, order is introduced into a mass of deposits hitherto the home of much confusion and uncertainty.

Below is added the correlation of these rocks with those of the First Survey.

Gray calcareous shale.	Scalent gray marls.
Variegated shale.	Surgent variegated marls.
Red shale.	Surgent red shale.

THE NIAGARA GROUP OF NEW YORK ABSENT FROM PERRY COUNTY, PA.

From the identifications here established it follows that nothing is left to represent the Niagara group in Perry county. If such a representative existed it must lie on the top of the iron ore capping the Clinton group. But the green shale of the passage beds has yielded no fossils that can belong to a bed of that age. It holds, as above shown, a mingled fauna of the Clinton and Lower Helderberg ages. There is, consequently, no conclusion possible, except to infer the absence of the Niagara group from Perry county.

The rapid thinning of the Niagara rocks in New York to the eastward prepares us for this conclusion. Two hundred and forty feet thick at Niagara Falls, it dwindles down to about one hundred and thirty feet in Wayne county, near Rochester. No other exposure occurs until we reach the slope of the Cincinnati anticline in Southwest Ohio, where it scarcely exceeds fifty feet.

THE UPPER LIMIT OF THE ONONDAGA GROUP.

It is scarcely necessary to follow this subject further, as no doubt exists concerning the age of the mass of Limestone overlying these shales. The Lower Helderberg group in Perry county has a well-defined summit, being capped by the Oriskany sandstone, but an ill-defined base where it meets the Onondaga gray shales. Difference of opinion, consequently, may exist concerning the exact plane at which the separation should be made. A short statement, therefore, of the facts and argument bearing on this point is appended.

The Lower Helderberg rocks in Perry county as here defined, consist of the following :

10′	White flint shales.	*Oriskany Sandstone.*
80′	Yellow flint shales.	
8′	Black cherty limestone.	*Lower Helderberg* 348′.
150′	Lime shales.	
100′	Massive limestone.	*Onondaga Gray Shales.*

Regarding the age of all these beds, except the lowest, there is no room for doubt.* The Lime shales and the White flint shales both abound in the fossils that characterize the Lower Helderberg group in New York. The following partial list is sufficient to support this assertion.

FOSSILS COMMON TO THE LIME SHALES OF PERRY COUNTY, PA., AND THE LOWER HELDERBERG ROCKS OF NEW YORK :

Discina discus, Hall.
† *Strophomena rugosa*, Dalman.
Rensselaeria mutabilis, Hall.
Rhynchonella nucleolata, Hall.
Rhynchonella formosa, Hall.
Merista lævis. Vanuxem.
Merista bella, Hall.
Megambonia aviculoidea, Hall.
Murchisonia minuta, Hall.

* This doubt is now removed by the note added below.

† This species and *Spirifera macropleura*, Con., abound in the White flint shale.

In regard to the lowest bed given in the section above, it must be admitted that in the determination of its horizon palæontology affords very little aid. Still palæontology is not our only guide in the solution of such problems. Indeed, she is only at best a guide whose authority is borrowed from stratigraphy, but nevertheless invaluable and indispensable.

COMPARISON OF THE LOWER HELDERBERG BEDS OF NEW YORK WITH THOSE REFERRED TO THAT GROUP IN PERRY COUNTY, PA.:

	New York.	*Perry County, Pa.*
Lower Helderberg.	Upper Pentamerus limestone.	
	Encrinital limestone.	Flint shales with Crinoids.
	Delthyris shaly limestone.	Lime shales.
	Lower Pentamerus limestone.	
	Water lime (Tentaculite bed.)	Massive limestone.
Onondaga	Magnesian rock.	
	Vermicular rock.	
	Gypseous marls.	Gray calcareous shale.

If the identifications previously made are accepted, there is no alternative but to admit the correlation of the Massive limestone with the Water lime, or to deny it any equivalent in the New York series. It is so closely connected with the overlying lime shales that to separate these would be in the highest degree illogical. They graduate into one another and can only be distinguished by the thinness of the beds and the abounding fossils of the upper strata. Their physical resemblance to the water lime is exceedingly great, but nowhere in Perry county have I been able to find any hydraulic beds. All slake equally when burnt.

PALÆONTOLOGICAL EVIDENCE.

In a case when stratigraphical evidence is so conflicting, the slight aid which palæontology can afford becomes exceedingly valuable. The Massive limestone being almost barren of fossils, the argument must rest on one or two species.

The Water lime is characterized in New York by abundance of *Leperditia alta*. As already mentioned, this fossil occurs for the last time, so far as yet observed in Perry county, in the massive limestone, where it is very abundant and often very large.

Occasionally, also, corals have been seen in this limestone, resembling species occurring in the lime shales above it, thus forming a link between the two. Below this limestone no fossils of this kind have been found in the shales.

Considering the high probability that this class of evidence would be increased by closer and wider search, especially in other counties, there can be no doubt that this Massive limestone should be included in the Lower Helderberg group of which it must then form the base. (See note, p. 502.)

If, however, any should prefer to relegate it to a system of "passage-beds" connecting the Onondaga and the Lower Helderberg, no valid objection can be raised to the course pending the discovery of further and conclusive evidence. It will not affect the arrangement above proposed.

I must remark in conclusion, that the suggestions now made are provisional, and therefore subject to change, according to future evidence. It does not seem probable, however, that the main outline of the plan will be altered.

Note. Since this paper was written I have obtained an excellent specimen of *Pterygotus Osborni*, Hall, from the massive limestone of Juniata county. This may be considered a proof of the identity of this limestone with the *Water lime* of New York. For this specimen I am indebted to Mr. Jas. Stevenson of this city (Akron, O.), a former resident of Juniata county, Pa.

SUMMARY OF THE GROUPING DETAILED ABOVE.

	New York.	*Perry County, Pa.*
Lower Helderberg Gr.	Upper Pentamerus limestone.	
	Encrinital limestone.	Flint shale with Crinoids.
	Delthyris shaly limestone.	Lime shales with *Tentaculites*, *Meristella*, &c.
	Lower Pentamerus limestone.	
	Water lime (Tentaculite bed).	Massive limestone with *Pterygotus* and *Lep. alta*.
Onondaga Gr.	Magnesian rock.	
	Vermicular rock.	
	Gypseous marls.	Gray, calcareous shale.
	Variegated shale.	Variegated shale.
	Red Shale.	Red shale.
		Passage-beds.
Clinton Group.	Limestone.	Limestone and hæmatite.
		Sandrock.
	Iron ore.	Hæmatite.
		Sandrock.
	Upper green shale.	Upper green shale and fossil ore.
	Iron ore and limestone.	Iron sandstone and fossil ore.
	Lower green shale.	Lower green shale.
	Medina sandstone.	

ERRATUM.

In Mr. Branner's paper on the growth of the Palm, for *Guilland*, read *Guillaud;* and for *Ser. VI, 176, 1877*, read, *Ser. V, 1—176 1877.*